

# United States Air Force Academy Cadets' Unprompted Knowledge of Concussions and “Bell Ringers” or “Dings”: Perceived Differences and Similarities

Michelle L. Weber Rawlins, PhD, ATC\*; Brian R. Johnson, PhD†; Johna K. Register-Mihalik, PhD, LAT, ATC‡; Karin DeAngelis, PhD§; Julianne D. Schmidt, PhD, ATC||; Christopher J. D'Lauro, PhD§

\*San Diego State University, CA; †Walter Reed Army Institute of Research, Silver Spring, MD; ‡University of North Carolina at Chapel Hill; §United States Air Force Academy, Colorado Springs; ||University of Georgia, Athens

**Context:** After a possible concussion mechanism, cadets are unlikely to have a list of concussion signs and symptoms at their disposal. As such, unprompted concussion knowledge may be an essential factor in personal recognition of injury.

**Objective:** To explore determinants that contributed to United States Air Force Academy (USAFA) cadets' disclosure of a concussion. This research focused on 1 of 8 overall discovered themes of unprompted concussion knowledge.

**Design:** Qualitative study.

**Setting:** Military academy.

**Patients or Other Participants:** Cadets at the USAFA (males = 23, females = 11, age = 19.91 ± 1.14 years).

**Main Outcome Measure(s):** We conducted 34 semistructured interviews. The transcribed text was analyzed in a 5-cycle process. From this process, 8 overall themes emerged, including unprompted concussion knowledge. Subthemes were concussion definition, concussion symptoms, “bell-ringer” or “ding” definition, “bell-ringer” or “ding” symptoms, and concussion versus “bell ringer” or “ding.”

**Results:** Many participants were able to describe a concussion fairly accurately. The most commonly listed concussion signs and symptoms were dizziness (n = 22/34, 64.7%); “can't

remember”/“memory loss”/“forgetful” (n = 19/34, 55.9%); and headache (n = 16/34, 47.1%). The cadet participants characterized the most common bell-ringer or ding signs and symptoms as dizziness (n = 2/34, 5.9%) and headache (n = 2/34, 5.9%). Cadets also described how a bell ringer or ding differs from a concussion, often commenting that concussions were more severe than bell ringers or dings.

**Conclusions:** Overall, USAFA cadet participants listed common concussion signs and symptoms. However, they perceived differences between a concussion and a bell ringer or ding. Although decreasing the use of colloquial terms for concussion is recommended, use of these terms when examining a concussion history may be helpful. Concussion-education interventions should continue to focus on describing concussion signs and symptoms using cadets' own words to describe the injury (eg, “forgetful”) but differentiating between what may and may not be a concussion and encouraging individuals to consult health care providers regarding possible concussion symptoms.

**Key Words:** mild traumatic brain injuries, military academy, concussion recognition, concussion signs and symptoms

## Key Points

- United States Air Force Academy cadets identified common concussion signs and symptoms, including dizziness, “can't remember”/“memory loss”/“forgetful,” and headache.
- Health care professionals should avoid using colloquial terms to describe a concussion; however, using these terms to gain insight into the concussion history may be beneficial.
- Educational interventions should describe concussion signs and symptoms but also include targeted messages encouraging individuals to consult health care providers to determine if a concussion has been sustained.

United States Air Force Academy (USAFA) cadets are at particular risk for sustaining a concussion, as reflected by the fact that 512 concussions were recorded among nearly 4100 cadets in slightly more than a 3-year span.<sup>1</sup> In order to seek appropriate medical treatment, an individual must first recognize that a concussion may have occurred.<sup>2–4</sup> Because not all signs and symptoms of a concussion are outwardly noticeable, the person experiencing possible concussion signs and symptoms must first acknowledge that what he or she is experiencing may be a concussion and then decide to seek

medical treatment. Thus, recognition relates to concussion knowledge, and most concussion-education interventions have focused on concussion knowledge, including symptom identification.<sup>5–8</sup> Concussion knowledge has primarily been examined using researcher-driven “check all that apply” or Likert-scale surveys instead of open responses.<sup>4,9,10</sup> When people experience a suspected concussion, they likely do not have access to a list of symptoms to determine if what they are initially experiencing is indeed a concussion. Instead of merely recognizing symptoms on a list, individuals must recall them in an environment very

different from that of most concussion-knowledge studies.<sup>11</sup> After any perceived concussion, the person still must decide, in the moment, whether to seek medical treatment.

More concussion knowledge does not necessarily relate to better concussion-reporting intentions or behavior.<sup>3,5,12,13</sup> However, as previously mentioned, one needs a basic knowledge of concussion signs and symptoms to recognize that what he or she is experiencing may be a concussion<sup>5</sup> and begin the reporting process; hence, recognition is still an important step before disclosure. Typical concussion-knowledge tests may cue certain responses, but open response allows free recall, which may more accurately reflect contemporaneous knowledge and informal beliefs less likely to be anticipated by researchers. Our aim was to fill the gap in understanding how the cadets themselves described concussion with free recall using their words as data. The overall purpose of this study was to explore factors that led USAFA cadets to either disclose or conceal a concussion. Eight themes were discovered in the larger study<sup>14</sup>; the current article focuses on the theme and subthemes related to unprompted concussion knowledge. This portion of the study highlights how concussions are recognized and understood using free recall. Understanding these processes will allow us to create educational interventions with these principles in mind.

## METHODS

The methods for this study were part of a larger study and have been described earlier.<sup>14</sup> This study was approved by the USAFA Institutional Review Board before data collection. We recruited first- and third-year cadets in their mandatory behavioral science course and offered extra credit for study involvement. Participants completed baseline concussion assessments and a 5-minute concussion-education presentation approximately 9 to 10 months before data collection (approximately 10 months earlier for first-year cadets and about 9 months prior for third-year cadets). They checked a box on a consent form if they were willing to be interviewed (identity protection was ensured) and were reminded that they could stop the interview at any time without penalty. Two scripts were developed for data collection by 3 concussion and qualitative researchers: 1 for cadets with a concussion history and 1 for cadets without a concussion history (Table 1). Interview scripts were designed with a phenomenological philosophical framework<sup>14</sup> and began with 2 introductory questions before proceeding to specific questions relating to the topic and then closing questions.<sup>15</sup> In the study design phase, we anticipated that individuals with a concussion history and those without a concussion history might answer interview questions differently, specifically recalling a particular concussion event and their experience; however, the 2 scripts were mostly similar. Participants also completed a preinterview demographic form. We conducted pilot interviews before data collection and did not change the interview scripts after those interviews. Two members of the research team (M.L.W.R. and C.J.D.) conducted all interviews. Interviews were approximately 10 to 35 minutes long and were conducted until saturation was achieved for both scripts. We were confident that saturation was achieved after 12 interviews with individuals who had a concussion history and 11 with individuals who did not

have a concussion history. However, because we established data trustworthiness using prolonged exposure, we completed an additional 5 interviews with individuals who had a concussion history and an additional 6 interviews with those who did not have a concussion history.

Once each interview ended, the audio files were sent to a professional transcription company (Rev.com). When the transcripts were returned, the lead investigator (M.L.W.R.) listened to each audio file while reading the transcript to ensure accuracy and redacted any identifying information.

We used a 5-cycle process to analyze the transcripts as described by Anderson,<sup>16</sup> Wertz et al,<sup>17</sup> and Weber Rawlins et al.<sup>14</sup> Cycles 1 and 2 consisted of an initial view into the topic, which was usually completed in an introduction and literature review. Data were collected and summarized in cycle 3. To complete cycle 3, the lead researcher first read the entire data corpus. Five transcripts for each interview script were randomly selected and read by a 4-person research team.<sup>14</sup> The team then met to deliberate and create an initial codebook. During this meeting, the team determined that both interview scripts elicited similar responses and thus could be analyzed together. The lead researcher read all transcripts to code the themes and subthemes as developed from the initial codebook. Eight themes emerged from this process: perceived costs following concussion, cultural differences within squadrons, educational initiatives, the need to disclose, peer encouragement/advocacy, rumors, self-management, and unprompted knowledge. To permit a sufficient analysis of each theme, we focused this article on unprompted concussion knowledge. Cycles 4 and 5 involved relating the findings to other research literature and creating final interpretations. We also counted the frequency of the mentioned signs and symptoms.

As described earlier, data credibility was established through prolonged exposure.<sup>18</sup> We also called on 2 external reviewers to establish dependability and confirmability.<sup>14,18</sup> Finally, we calculated the demographic data using frequencies, means, and SDs.

## RESULTS

Overall, we interviewed a total of 34 participants (males = 23, females = 11, age = 19.91 ± 1.14 years).<sup>14</sup> Full participant demographics are provided in Weber Rawlins et al.<sup>14</sup> This article focuses on the theme of unprompted knowledge with the following 5 subthemes: definition, concussion symptoms, “bell-ringer” or “ding” definition, bell-ringer or ding symptoms, and concussion versus bell-ringer or ding.

### Concussion Definition

The USAFA cadets had many definitions of concussion. One cadet noted, “Some hard impact on the head or neck that causes some sort of disorientation.” Another participant stated,

So as I’ve always perceived it, any time that you’ve received either a blow to the head, or it could even be a full-body kind of thing, it’s just the fact that the brain moves in your skull and it bruises itself to a degree, and it slows down your cognitive reflexes, impairs judgment to a degree. Even though some of the side effects might

**Table 1. Interview Script<sup>a14</sup> Continued in Next Column**

Interview Question
1. To begin, please tell me about your time at the Air Force Academy. <ol style="list-style-type: none"> <li>What year student are you?</li> <li>If participant is a student athlete:               <ol style="list-style-type: none"> <li>Which sport do you participate in?</li> <li>How long have you been playing that particular sport?</li> </ol> </li> </ol>
2. If you had to stop being a member of the Air Force Academy today, how would you react? <ol style="list-style-type: none"> <li>How would your daily life change? Goals?</li> </ol>
3. Describe what the term “concussion” means to you. <ol style="list-style-type: none"> <li>Does a concussion differ from a “bell-ringer” or “ding?” If so, how?</li> </ol>
4. <i>For individuals with a concussion history:</i> On the demographic questionnaire, you indicated you had personally experienced a [concussion] and/or [bell-ringer/ding]. The following questions will be about your experience. What went through your head immediately following your [concussion] and/or [bell-ringer]? <ol style="list-style-type: none"> <li>What led you to believe it was a [concussion] and/or [ding]?</li> <li>Did you report the injury? To whom? How long after impact?</li> <li>Why did you or why did you not report the injury?</li> <li>Do you feel as though you were treated differently after injury?               <ol style="list-style-type: none"> <li>Family, friends?</li> </ol> </li> <li>(If participant reported experiencing a concussion and bell-ringer) How did your concussion differ from the “bell-ringer” or ding?</li> </ol>
5. (If the participant indicated more than 1 concussion/bell-ringer was sustained, the following questions were asked) Can you describe each of your concussion experiences? <ol style="list-style-type: none"> <li>What went through your head immediately following your [concussion] and/or [bell-ringer]?</li> <li>For each concussion, what led you to believe your injury was a concussion?</li> <li>Did you report each injury? To whom? How long after impact?</li> <li>For each concussion, why did you or why did you not report the injury?</li> <li>Do you feel as though you were treated differently after injury?               <ol style="list-style-type: none"> <li>Family, friends?</li> </ol> </li> <li>(If participant reported experiencing multiple concussions and “bell-ringers”) How did your concussion differ from the “bell-ringer” or ding?</li> </ol>
6. <i>For individuals without a concussion history:</i> On the demographic questionnaire, you indicated you had never personally experienced a [concussion] and/or [bell-ringer/ding]. Can you describe someone you know who has had a concussion? <ol style="list-style-type: none"> <li>What led you to believe it was a [concussion] and/or [ding]?</li> <li>How were they acting?</li> <li>Did they report their injury?</li> <li>How were they treated postinjury from you and others?               <ol style="list-style-type: none"> <li>Family, friends?</li> </ol> </li> </ol>
7. What are your thoughts regarding concussion reporting? <ol style="list-style-type: none"> <li>Why would individuals report a concussion?               <ol style="list-style-type: none"> <li>Long-term health consequences (eg, dementia, CTE, etc)?</li> <li>Short-term health consequences (eg, delayed reaction time, impaired balance, etc)?</li> </ol> </li> <li>Why would someone at the Air Force Academy not report their concussion?               <ol style="list-style-type: none"> <li>Desire to continue playing?</li> <li>Not knowing it was a concussion?</li> </ol> </li> </ol>
8. If you suspected you might have a concussion next week, describe how you would approach the situation. <ol style="list-style-type: none"> <li>What thoughts do you think would go through your mind?</li> <li>What symptoms would lead you to believe you had a concussion?</li> <li>To whom would you report your injury?</li> <li>Would your answer change after you become a pilot?</li> </ol>
9. I am going to start this sentence and would like you to finish it, “When I experience possible concussion symptoms, I . . .” <ol style="list-style-type: none"> <li>What factors would influence your reporting or not-reporting injury?</li> </ol>

**Table 1. Continued From Previous Column**

Interview Question
10. Is there anything else you would like to add about concussion reporting?
11. Are there any questions or topics I have not asked that you would like to discuss?

<sup>a</sup> The instrument is reproduced in its original format.

not be noticed, there still could be some type of damage there.

Another participant defined a concussion as

. . . a form of mental disorder where you forget and can't really remember things. It doesn't last for long after your memory comes back, but I'm not really sure if it comes back intact as it was originally. But pretty much, like 95%.

### Concussion Symptoms

Frequencies of concussion signs and symptoms listed by participants are shown in Table 2. The most commonly cited concussion sign and symptom was dizziness (n = 22/34, 64.7%), followed by “can't remember”/“memory loss”/“forgetful” (n = 19/34, 55.9%), and headache (n = 16/34, 47.1%).

### Bell-Ringer or Ding Definition

Participants defined a bell ringer or ding as,

I think it does differ, because with a bell ringer or a ding, I guess from my . . . From the way it sounds to me, it's kind of like you get knocked in the head, and kind of hurt for a minute, but then you recover and you're fine the next day, I guess?

Another cadet said,

I think it does just for the severity of it. You're disorientated and all that, but a concussion goes a little farther than just being disorientated. I figure that as more of just a shock that occurs.

### Bell-Ringer or Ding Symptoms

Frequencies of bell-ringer or ding signs and symptoms listed by participants are given in Table 3. The most common bell-ringer or ding signs and symptoms were dizziness (n = 2/34, 5.9%) and headache (n = 2/34, 5.9%).

### Concussion Versus Bell-Ringer or Ding

The cadets described what they believed was the difference between concussions and bell ringers or dings. One cadet said,

I think it kind of goes back to, I mean, if you're hit in the head or if you're taking a shot to the upper body and your whole . . . kind of get, like, that whiplash effect, definitely I think you can have the same effects, even people who get hit and they'll black out for a second and they figure

**Table 2. Concussion Signs and Symptoms Listed by Participants (n = 34) Continued in Next Column**

Sign or Symptom	Frequency of Listing, No. (%)	Concussion Symptom Category <sup>a</sup>
Dizziness/dizzy	22 (64.7)	Symptoms
Can't remember/memory loss/ forgetful	19 (55.9)	Symptoms
Headache	16 (47.1)	Symptoms
Sensitivity to light	16 (47.1)	Symptoms
Nausea	16 (47.1)	Symptoms
Sleep disturbances/tired/fatigue	11(32.4)	Sleep/wake disturbances
Lack of focus/difficulty focusing	9 (26.5)	Symptoms
Loss of consciousness/passing out/knocked out/black out	9 (26.5)	Physical signs
Sensitivity to noise/needs quiet/ sounds hurt	9 (26.5)	Symptoms
Blurry/blurred vision	7 (20.6)	Physical signs
Vomiting/puking/throwing up	7 (20.6)	Physical signs
Feeling abnormal/off/out of sorts/ out of it	6 (17.6)	Behavioral changes
Cognitive impairments	5 (14.7)	Cognitive impairment
Amnesia/didn't remember events right after incident/not remembering things from that event	5 (14.7)	Physical signs
Disorientation	4 (11.8)	Symptoms
Emotional	4 (11.8)	Behavioral changes
Concentration/can't concentrate	4 (11.8)	Symptoms
Balance	3 (8.8)	Balance impairment
Confusion	3 (8.8)	Symptoms
Increase with mental activity	3 (8.8)	Other
Slowed reaction time	3 (8.8)	Cognitive impairment
Amnesia	2 (5.9)	Physical signs
Fear	2 (5.9)	Behavioral changes
Mood	2 (5.9)	Behavioral changes
Head pain	2 (5.9)	Symptoms
Pupils don't dilate	2 (5.9)	Physical signs
Slurred speech	2 (5.9)	Physical signs
Irritability/angry	2 (5.9)	Behavioral changes
Difficulty thinking/critical thinking	2 (5.9)	Physical signs
Hearing "beeps"	1 (2.9)	Other
Vertigo	1 (2.9)	Physical signs
Biological features	1 (2.9)	Other
Can't complete basic skills	1 (2.9)	Physical signs
Can't write properly	1 (2.9)	Physical signs
Combination of symptoms	1 (2.9)	Other
Dazed	1 (2.9)	Symptoms
Delusional	1 (2.9)	Behavioral changes
Trouble thinking	1 (2.9)	Symptoms
Unable to think critically	1 (2.9)	Symptoms
Drainage from the ears	1 (2.9)	Other
Dumb	1 (2.9)	Behavioral changes
Dysfunction	1 (2.9)	Cognitive impairment
Depression	1 (2.9)	Behavioral changes
Psychological dysfunction	1 (2.9)	Behavioral changes
Rage	1 (2.9)	Behavioral changes
Glazy	1 (2.9)	Symptoms
Impaired abilities	1 (2.9)	Other
Impaired reflexes	1 (2.9)	Physical signs
Impaired sensory function	1 (2.9)	Physical signs
Sight loss	1 (2.9)	Physical signs
Spotty vision	1 (2.9)	Physical signs
Tunnel vision	1 (2.9)	Physical signs
Impact on learning	1 (2.9)	Other
Lightheadedness	1 (2.9)	Symptoms
Loopy	1 (2.9)	Behavioral changes
Mental foggiess	1 (2.9)	Symptoms

**Table 2. Continued From Previous Column**

Sign or Symptom	Frequency of Listing, No. (%)	Concussion Symptom Category <sup>a</sup>
Mental performance and capacity	1 (2.9)	Cognitive impairment
Motor skills	1 (2.9)	Cognitive impairment
Not walk properly	1 (2.9)	Physical signs
Out of body experience	1 (2.9)	Symptoms
Affect your performance in basically anything	1 (2.9)	Other
Personality changes	1 (2.9)	Behavioral changes
Poor hand-eye	1 (2.9)	Cognitive impairment
Random behavior	1 (2.9)	Behavioral changes
Restless	1 (2.9)	Symptoms
Shortness of breath	1 (2.9)	Symptoms
Sluggish	1 (2.9)	Sleep/wake disturbances

<sup>a</sup> Concussion signs and symptoms categories are symptoms, physical signs, balance impairment, behavioral changes, cognitive impairment, and sleep/wake disturbances.<sup>22</sup>

out where they are once they're looking up at the sky. Sometimes that happens. And there's not symptoms I've seen, or in my case, have never shown up afterwards. But I'm sure that they definitely ... there's a correlation depending on the type of injury or the type of collision.

**Table 3. "Bell-Ringer" or "Ding" Signs and Symptoms Listed by Participants (n = 34)**

Frequency of Listing, No. (%)	Sign or Symptom	Concussion Symptom Category <sup>a</sup>
2 (5.9)	Dizzy	Symptoms
	Headache	Symptoms
1 (2.9)	Balance	Balance impairment
	Dazed	Symptoms
	Disoriented	Symptoms
	Losing focus	Symptoms
	Head hurts	Symptoms
	Hear the "zzzz" kind of thing	Other
	Knocked out	Physical signs
	Lapse in event	Physical signs
	Losing your breath	Symptoms
	Moving a lot slower	Cognitive impairments
	Nasal congestion/nasal cavity cleared	Other
	Nausea	Symptoms
	Rattled	Other
	Can't remember	Symptoms
	Ringin sensation in ears	Other
	Seeing stars	Symptoms
	Severity of the symptoms	Other
	Shake head off and get back out there	Other
	Shock of what occurred	Other
	Tired	Sleep/wake disturbances
	Weren't on their game	Other
	Wind knocked out of you	Other

<sup>a</sup> Concussion signs and symptoms categories are symptoms, physical signs, balance impairment, behavioral changes, cognitive impairment, and sleep/wake disturbances.<sup>22</sup>

Another participant described how the duration of symptoms played a role:

I feel like that would be more 5 to 10 minutes of just after it happened, whereas a concussion you feel it an hour or all day.

Another cadet discussed a longer duration of symptoms:

I would say just the longevity of the symptoms. I think if it's only like for a day, then it's not a concussion.

One individual commented on the duration of symptoms in more depth:

I think concussion is more on the severe end. If you think of just getting hit in the head, and maybe you have a few seconds of dizziness and then you shake it off, I don't think that qualifies as a concussion. It's only when those symptoms persist for, say more than a few hours, or a day, that it really can be qualified as a concussion.

Finally, a cadet explained that often what we suspect is a bell ringer may also be a concussion: "... I'd say what I feel like most people would refer to as a bell ringer is actually a concussion."

## DISCUSSION

Overall, the participants' free recall communications reflected a high level of concussion knowledge. They were able to define concussions and bell ringers or dings, listed many common concussion signs and symptoms, and described their perceptions of the difference between concussions and bell ringers or dings. In order to recognize and disclose a concussion, one must understand what a concussion is and that the symptoms being experienced are abnormal. If concussion-education programs can build foundational knowledge regarding what a concussion is, how concussions relate to bell ringers or dings, what the typical signs and symptoms of concussion are, and the importance of reporting any abnormal symptoms, concussion-disclosure rates may increase.

Concussions are defined in many ways.<sup>19–22</sup> The Fifth International Conference on Concussion in Sport defined a concussion as "a traumatic brain injury induced by biomechanical forces."<sup>22(p2)</sup> No matter which definition of concussion is adopted, a common theme is that concussions are injuries that affect brain function caused by biomechanical processes and may or may not involve loss of consciousness. These definitions are useful for clinicians in guiding diagnosis. Participants in this study also had a wide range of concussion definitions. However, numerous cadets' definitions included a mechanism of injury (eg, impact to the head or body) and resulted in some type of abnormal symptoms. A specific definition of a concussion does not necessarily need to be memorized and would likely even be unrealistic, yet it is important for cadets to recognize if what they are experiencing after a possible mechanism of injury could be a concussion. Our research highlighted the concussion definitions used by participants when unprompted; it is important to understand what

individuals perceive a concussion is in order for them to recognize the injury and seek medical care.

The most common concussion signs and symptoms are headache and dizziness.<sup>23</sup> These were most frequently noted as signs and symptoms by our participants when describing both concussions and bell ringers or dings. Loss of consciousness was cited as a symptom of a concussion by 26.5% of cadets. In actuality, loss of consciousness only occurred in 9% of reported concussions.<sup>24</sup> Therefore, misconceptions regarding loss of consciousness persist, and concussion education should include this information. Other less common symptoms not usually associated with concussions were described as "hearing beeps" or "drainage from the ears." Recently, Register-Mihalik et al<sup>25</sup> found similar results in that cadets most frequently identified headache and pressure in the head as concussion symptoms but less often identified emotional symptoms. Similarly, nearly 12% and 6% of the participants in our sample remarked on "emotional" or "mood" symptoms, respectively, as opposed to 47% who identified headache. It is encouraging that cadets in this study and that of Register-Mihalik et al<sup>25</sup> recognized similar concussion signs and symptoms when unprompted and when given a list to choose from, indicating that cadets may answer similarly in a real-world situation when asked about symptoms. Concussion-education interventions should target typical concussion signs and symptoms, including emotional symptoms, and should address "red flags" such as "drainage from the ears" or other signs that would indicate a medical emergency.

Although *bell ringer* lacks a formal definition, Register-Mihalik et al<sup>4</sup> found that athletes often used this term to depict a "brief, transient alteration in neurologic function."<sup>4(p 647)</sup> Our USAFA cadets also described a bell ringer or ding as brief (eg, "... for a minute ..."), and an alteration in neurologic function (eg, "You're disoriented ..."). Register-Mihalik et al<sup>4</sup> stated that even though not all bell ringers or dings are concussions, they at minimum warrant medical attention to determine if a concussion occurred before consideration can be given to returning the athlete to sport. We are the first to examine how cadets themselves define a *bell ringer* and *ding*. This information can be used to better relate to patients using targeted educational interventions incorporating their own phrasing and words, especially if this terminology is intended to minimize perceptions of seriousness.

When describing a concussion, health care professionals are encouraged not to use colloquial terms such as a bell ringer or ding, "clearing the cobwebs," "seeing stars," etc. However, authors have continued to observe misconceptions regarding concussions and bell ringers or dings in student-athletes.<sup>26</sup> Cadets frequently discussed the duration of symptoms in differentiating a concussion and bell ringer or ding, which was noteworthy. Currently, no concussion definition includes a minimum duration of symptoms.<sup>19–22</sup> Given these continuing misconceptions regarding the differences between concussions and bell ringers or dings, clinicians may consider using these terms when asking student-athletes or cadets if they have a concussion history or determining if what they are currently experiencing is a concussion.

Many authors<sup>3,12,13</sup> have commented that an increase in concussion knowledge does not always equal an increase in

concussion disclosure. Nonetheless, to recognize a concussion, one must have the foundational knowledge of the signs and symptoms.<sup>2-5</sup> This can be delivered during a concussion-education intervention and should include a wide range of symptoms, especially because numerous concussion signs and symptoms were used to describe a concussion versus a bell ringer or ding. For example, discussing symptoms using cadet terminology such as “feeling loopy” may also be beneficial. Our study highlighted specific educational targets that may be included in concussion-education interventions. This information is the first of its kind using wording and targeted notes from the patient perspective and providing clear evidence for educational concepts and novel educational strategic opportunities. It can be used to supply clinicians with the information needed to approach education and concussion history in a manner that helps cadets identify symptoms if they experience them, not just via a symptom checklist.

Qualitative research does not aim to be generalizable, and our results apply only to those USAFA cadet participants we interviewed. Additionally, we analyzed the data similarly between those with and those without a concussion or bell-ringer or ding history. Future investigators should examine educational interventions that include more colloquial terms to describe a concussion in a broad population. Authors should also explore the mechanisms that may influence a cadet’s definition of a concussion or bell ringer or ding, such as peer relationships, previous history, and sport influences.

## CONCLUSIONS

Cadets in our sample were able to describe and identify many concussion-related symptoms without cues from the researchers, yet many participants viewed *bell ringer* and *ding* in ways that appeared to minimize the seriousness of the injury. Clinicians may use this information to accurately describe concussions, discouraging colloquial terms such as a bell ringer or ding, and discussing the common concussion signs and symptoms and terms found in this study. By highlighting concussion information from the cadet perspective, including common terminology used by cadets, we may better design educational interventions and increase concussion disclosure.

## ACKNOWLEDGMENTS

We recognize the USAFA cadets who were willing to give their time for this study and Cailee E. Welch Bacon, PhD, ATC, for her assistance in interview script development.

## FINANCIAL DISCLOSURES

This project was funded with support from the National Collegiate Athletic Association–Department of Defense Research Grand Challenge: “Changing Attitudes About Concussions in Young and Emerging Adults.” Additional support for this project was obtained from the US Air Force Summer Faculty Fellowship Program.

## Conflict of Interest

Michelle L. Weber Rawlins, PhD, ATC, and Julianne D. Schmidt, PhD, ATC, have received stipend and travel funds from the National Collegiate Athletic Association–Department of

Defense Research Grand Challenge: “Changing Attitudes About Concussions in Young and Emerging Adults” grant and the US Air Force Summer Faculty Fellowship Program. Johna K. Register-Mihalik, PhD, LAT, ATC; Brian R. Johnson, PhD; Julianne D. Schmidt, PhD, ATC; and Christopher J. D’Lauro, PhD, were awarded the described grant from the National Collegiate Athletic Association–Department of Defense Research Grand Challenge and received travel funds. Karin DeAngelis, PhD, has no conflicts of interest to declare.

## Disclosure

The views expressed in this article are those of the authors and do not necessarily reflect those of the USAFA or the US Department of Defense. Material has been reviewed by the Walter Reed Army Institute of Research. There is no objection to its presentation and/or publication. The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting true views of the Department of the Navy, the Department of the Army, or the Department of Defense. Several authors are employees of the US Government. This work was prepared as part of their official duties. Title 17 USC Å 105 provides that “Copyright protection under this title is not available for any work of the United States Government.” Title 17 USC Å 101 defines a US Government work as a work prepared by an employee of the US Government as part of that person’s official duties. The investigators have adhered to the policies for protection of human subjects as prescribed in AR 70-25.

## REFERENCES

1. D’Lauro C, Johnson BR, McGinty G, Allred CD, Campbell DE, Jackson JC. Reconsidering return-to-play times: a broader perspective on concussion recovery. *Ortho J Sports Med.* 2018;6(3):2325967118760854. doi:10.1177/2325967118760854
2. Chrisman SP, Quitiquit C, Rivara FP. Qualitative study of barriers to concussive symptom reporting in high school athletes. *J Adolesc Health.* 2013;52(3):330–335.e3. doi:10.1016/j.jadohealth.2012.10.271
3. Kroshus E, Baugh CM, Daneshvar DH, Viswanath K. Understanding concussion reporting using a model based on the theory of planned behavior. *J Adolesc Health.* 2014;54(3):269–274.e2. doi:10.1016/j.jadohealth.2013.11.011
4. Register-Mihalik JK, Guskiewicz KM, McLeod TCV, Linnan LA, Mueller FO, Marshall SW. Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. *J Athl Train.* 2013;48(5):645–653. doi:10.4085/1062-6050-48.3.20
5. Weber Rawlins ML, Suggs DW, Bierema L, Miller LS, Reifsteck F, Schmidt JD. Examination of collegiate student-athlete concussion reporting intentions and behavior. *J Clin Transl Res.* 2020;5(4):186–196.
6. Heads Up. Centers for Disease Control and Prevention. Updated February 25, 2021. Accessed August 4, 2016. <http://www.cdc.gov/headsup/index.html>
7. Thinkfirst. National Injury Prevention Foundation. Accessed April 7, 2018. <http://www.thinkfirst.org>
8. Barrow Brainbook. Barrow Neurological Institute. Accessed April 7, 2018. <https://www.barrowneuro.org/resource/barrow-brainbook/>
9. Rosenbaum AM, Arnett PA. The development of a survey to examine knowledge about and attitudes toward concussion in high-school students. *J Clin Exp Neuropsychol.* 2010;32(1):44–55. doi:10.1080/13803390902806535
10. Kaut KP, DePompei R, Kerr J, Congeni J. Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. *Clin J Sport Med.* 2003;13(4):213–221. doi:10.1097/00042752-200307000-00004

11. Tulving E, Thomson DM. Encoding specificity and retrieval processes in episodic memory. *Psychol Rev.* 1973;80(5):352–373. doi:10.1037/h0020071
12. Kroshus E, Garnett B, Hawrilenko M, Baugh CM, Calzo JP. Concussion under-reporting and pressure from coaches, teammates, fans, and parents. *Soc Sci Med.* 2015;134:66–75. doi:10.1016/j.socscimed.2015.04.011
13. Kroshus E, Baugh CM, Daneshvar DH, Nowinski CJ, Cantu RC. Concussion reporting intention: a valuable metric for predicting reporting behavior and evaluating concussion education. *Clin J Sport Med.* 2015;25(3):243–247. doi:10.1097/JSM.000000000000137
14. Weber Rawlins ML, Johnson BR, Register-Mihalik JK, DeAngelis K, Schmidt JD, D'Lauro CJ. United States Air Force Academy cadets' perceived costs of concussion disclosure. *Mil Med.* 2020;185(1–2):e269–e275. doi:10.1093/milmed/usz162
15. Suzuki LA, Ahluwalia MK, Arora AK, Mattis JS. The pond you fish in determines the fish you catch: exploring strategies for qualitative data collection. *Couns Psychol.* 2007;35(2):295–327. doi:10.1177/0011000006290983
16. Anderson R. Intuitive inquiry: exploring the mirroring discourse of disease. In: Wertz FJ, McSpadden E, Charmaz K, McMullan LM, Anderson R. *Five Ways of Doing Qualitative Analysis. Phenomenological Psychology, Grounded Theory, Discourse Analysis, Narrative Research, and Intuitive Inquiry.* The Guilford Press; 2011:243–278.
17. Wertz FJ, McSpadden E, Charmaz K, McMullan LM, Anderson R. *Five Ways of Doing Qualitative Analysis. Phenomenological Psychology, Grounded Theory, Discourse Analysis, Narrative Research, and Intuitive Inquiry.* The Guilford Press; 2011.
18. Lincoln YS, Guba EG. But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New Dir Eval.* 1986;30:73–84. doi:10.1002/ev.1427
19. Harmon KG, Drezner JA, Gammons M, et al. American Medical Society for Sports Medicine position statement: concussion in sport. *Br J Sports Med.* 2013;47(1):15–26. doi:10.1136/bjsports-2012-091941
20. Broglio SP, Cantu RC, Gioia GA, et al. National Athletic Trainers' Association position statement: management of sport concussion. *J Athl Train.* 2014;49(2):245–265. doi:10.4085/1062-6050-49.1.07
21. Giza CC, Kutcher JS, Ashwal S, et al. Summary of evidence-based guideline update: evaluation and management of concussion in sports: report of the Guideline Development Subcommittee of the American Academy of Neurology. *Neurology.* 2013;80(24):2250–2257. doi:10.1212/WNL.0b013e31828d57dd
22. McCrory P, Meeuwisse W, Dvořák J, et al. Consensus statement on concussion in sport—the 5th International Conference on Concussion in Sport held in Berlin, October 2016. *Br J Sports Med.* 2017;51(11):838–847. doi:10.1136/bjsports-2017-097699
23. O'Connor KL, Baker MM, Dalton SL, Dompier TP, Broglio SP, Kerr ZY. Epidemiology of sport-related concussions in high school athletes: National Athletic Treatment, Injury and Outcomes Network (NATION), 2011–2012 through 2013–2014. *J Athl Train.* 2017;52(3):175–185. doi:10.4085/1062-6050-52.1.15
24. Guskiewicz KM, Weaver NL, Padua DA, Garrett Jr WE. Epidemiology of concussion in collegiate and high school football players. *Am J Sports Med.* 2000;28(5):643–650. doi:10.1177/03635465000280050401
25. Register-Mihalik JK, Cameron KL, Kay MC, et al. Determinants of intention to disclose concussion symptoms in a population of US military cadets. *J Sci Med Sport.* 2019;22(5):509–515. doi:10.1016/j.jsams.2018.11.003
26. McLeod TCV, Bay RC, Heil J, McVeigh SD. Identification of sport and recreational activity concussion history through the preparticipation screening and a symptom survey in young athletes. *Clin J Sport Med.* 2008;18(3):235–240. doi:10.1097/JSM.0b013e3181705756

---

Address correspondence to Michelle L. Weber Rawlins, PhD, ATC, 5500 Campanile Drive, San Diego, CA 92128. Address email to [Mrawlins@sdsu.edu](mailto:Mrawlins@sdsu.edu).